The Guided Inquiry Model of Scientific Literacy: A Meta-Analytic Study

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Abstrak

In the last ten years, there have been many studies on learning models that can increase scientific literacy. One of the models studied is the Guided Inquiry learning model with varying results. So this study aims to verify how much influence the Guided Inquiry model has on students' scientific literacy based on category, level of education, and based on time zones in the territory of Indonesia. This study uses a quantitative descriptive method. Data collection was taken from the last ten years (2013-2022), which was carried out in the Scopus database, Google Scholar, and ERIC (Education Resources Information Center). The number of articles that became the population in this study was 111 articles and 20 articles as samples that met the criteria of this study. The result of the Effect Size on the Guided Inquiry model on scientific literacy is 2.65 in the high category. The effect size of the Guided Inquiry model on scientific literacy based on education level from Elementary School (SD) is 2.29, at the Junior High School (SMP) level is 2.44, at the Senior High School (SMA) level is 3.13, and at university level of 1.45. Effect Size of the Guided Inquiry model on scientific literacy based on the time zone in Indonesia. In the Western Indonesian time zone, it is 3.40 and in the Central Indonesian time zone, it is 2.103. So that the Guided Inquiry model can improve students' scientific literacy skills.

Keywords: Discovery Learning, Guided Inquiry, Meta Analysis, Scientific Literacy , Problem Based Learning

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INTRODUCTION

Data published by the World Population Review, in 2021 Indonesia is in 54th position out of a total of 78 countries included in the world education level ranking (Akbar Endarto & Martadi, 2022). This position illustrates the level of education in Indonesia is still relatively low. One of the reasons for the low level of education in Indonesia, especially in the 21st century, is the lack of scientific literacy in students. Scientific literacy is one of the main abilities that are important for students to be able to organize, analyze, and understand all the information obtained properly. Students who have good scientific literacy will easily understand the surrounding environment such as interactions in science, humans, and technology (Jofi Kuswanto et al., 2021). The international scale scientific literacy assessment conducted by PISA in 2018 placed Indonesia in the 74th or sixth place in literacy. Reading ability with a score of 371 is in the 74th position, math ability with 379 is in the 73rd position, and science ability with a score of 396 is in the 71st position (Winaya & Sudiarta, 2022). Based on these results, it can be seen that reading ability has the lowest rank compared to other abilities.

The low science literacy in Indonesia is a shared responsibility, especially for educators who interact directly with students. There needs to be innovation in the use of models and methods in learning activities that aim to improve students' scientific literacy skills. Some models can be used in learning activities to increase scientific literacy, such as Guided Inquiry, Discovery Learning,and Problem-Based Learning. Guided Inquiry is a model whose learning activities use the Inquiry approach. The process of learning activities in Guided Inquiry helps students make discoveries to answer problems given by educators.(Fahmia, H. Karjiyati, n.d.). Then, the Discovery Learning model can help students to independently understand a concept and theory through an impulsive process to conclude.(Fahmia, H. Karjiyati, n.d.) Meanwhile, the Problem-Based Learning (PBL) model is one of the innovations in learning because in the PBL model students are required to optimize their thinking skills with group activities in systematic teams so that students can use, hone, test, and improve their thinking skills simultaneously (Pratama, M. Arifky, 2022).

Research related to the effect of scientific literacy on Guided Inquiry, Discovery Learning, and Problem-Based Learning models has been carried out a lot in the last ten years, including the Guided Inquiry model conducted by N. Ngertini et al,2014 (Ngertini, 2014), Ummu et al, 2021(Ummu Aiman, Dian Meilani, 2021), Jofi et al, 2021 (Jofi Kuswanto et al., 2021), E V Aulia et al, 2017(E V Aulia, S Poedjiastoeti, 2018). Then in the Discovery Learning model including by Eva dan Ewisahrani, 2021(Nursa'ban & Ewisahrani, 2021), Eggi Aqmar et al, 2021(Eggi Aqmar Amazida, Rahmi, 2021), Aldi Yudawan et al, 2015(Yudawan et al., 2015), Nur Khasanah et al, 2016(Khasanah & Dwiastuti, 2016). In the Problem Based Learning model, including by Easy Zulfah et al, 2022(Zulfa et al., 2022), Fathiah dan Laili et al, 2020(Alatas & Fauziah, 2020), Greydio Raidel dan Cosma Poluakan, 2022(Greydio Raidel Lendeon, 2022). Based on the research articles above, it can be proven that a lot of research has been done, especially on these three models of scientific literacy. However, there are still differences in each of these articles regarding the good results of presenting the results data and how much influence these models have on scientific literacy. One solution to finding out is to carry out a systematic review of the results of various previous studies, by using a meta-analytic study whereby using a meta-analytic study researchers can find out the influence of these models on scientific literacy by looking at the results of the final calculation of the Effect Size of each model.

Many kinds of research related to meta-analytic studies of scientific literacy have been carried out in recent years, including several types of models or other learning methods such as the STEM model (Mardia Roza T et al, 2022), the PBL model (Lenty et al, 2021), and the Inquiry (Fani et al, 2020). However, there are relatively few published studies regarding the effect of the Guided Inquiry model on scientific literacy, especially those that compare the main model with two other additional models.

Therefore, this research was conducted to determine the effect size of the effect of the Guided Inquiry model on scientific literacy by analyzing previous research. Research samples were obtained from the Scopus data base, Eric (Education Resources Information Center), and Google Scholar. With the help of POP (Publish or Perish) applications..

METHOD

Meta-analysis is one of the quantitative research methods by analyzing quantitative data from previous research results to accept or reject the hypotheses proposed in these studies. The purpose of meta-analysis is to reveal facts about similar topics, combine findings from several studies conducted at various times and places, and achieve the most accurate quantitative results through increasing sample size.(Aytaç, 2019) The research data was analyzed using a descriptive analysis approach. This approach is used to explain in detail and detail related to variables. A quantitative descriptive approach is carried out to see, review, and describe by processing data in the form of numbers that are examined in this study so that conclusions can be drawn.

1. Finding and Classifying Data

This research was conducted from September to November 2022. The population used in this study came from scientific articles using several keywords such as "Model Guided Inquiry, Discovery Learning, Problem-Based Learning" related to scientific literacy that has been published in the database Google Scholar, ERIC (Education Resources Information Center), Scopus with the help of the POP (Publish or Perish) application and obtained 111 journals. In the Guided Inquiry model, there are 45 articles, in the Discovery Learning model there are 33 articles, and in the Problem-Based Learning model there are 33 articles. The samples used in this study are scientific articles that are already in the database related to the Guided Model learning model. Inquiry, Discovery Learning, and Problem-Based Learning on scientific literacy. There are several types of categories used in this study: a) The scientific articles used were made by general researchers, b) The scientific articles used experimental research methods, c) The scientific articles used were already in research databases such as Google Scholar, ERIC (Education Resources Information Center), and with the help of POP applications (Publish or Perish), d) Scientific articles using a statistical approach that produces statistical data such as Effect Size and other forms of data, e) Scientific articles used in this research are articles within the last 10 years, namely 2013-2022, f) and Articles scientific research made related to the Model Guided Inquiry, Discovery Learning, and Problem-Based Learning models for scientific literacy.

Table 1. Research Sample

No.	Variabel	Science Literacy		
		Scopus	Scholar	ERIC
1	GI	1	6	-
2	DL	-	4	-
3	PBL	-	9	-
Total			20	

Information:
GI : *Guided Inquiry*
DL : *Discovery Learning*
PBL : *Problem Based Learning*

Table 2. Guided Inquiry Sample Based on Education Level

No.	Variabel	Educational level			
		SD	SMP	SMA	Universitas
1	GI	1	1	4	1
2	DL	-	2	2	-
3	PBL	1	3	5	-
Total				20	

Information:
GI : *Guided Inquiry*
DL : *Discovery Learning*
PBL : *Problem Based Learning*

2. Data Coding and Data Analysis Techniques

The data used in this research is secondary data. The research data comes from several databases such as Scopus, Google Scholar, ERIC (Education Resources Information Center), Scopus, and the POP (Publish or Perish) application. The research instrument used in this study was in the form of coding data sheets related to predetermined variables. The design stages in this study used selection data in the form of coding data according to predetermined conditions. Providing data coding in the form of meta-analysis data with survey research techniques in scientific articles in the database. Coding data in this study uses letters of the alphabet, namely in the Guided Inquiry model with letters (A), in the Discovery Learning model with letters (B), and the Problem-Based Learning model with letters (C). The data analysis technique used in this

study is data meta-analysis. Several stages must be passed by researchers such as:

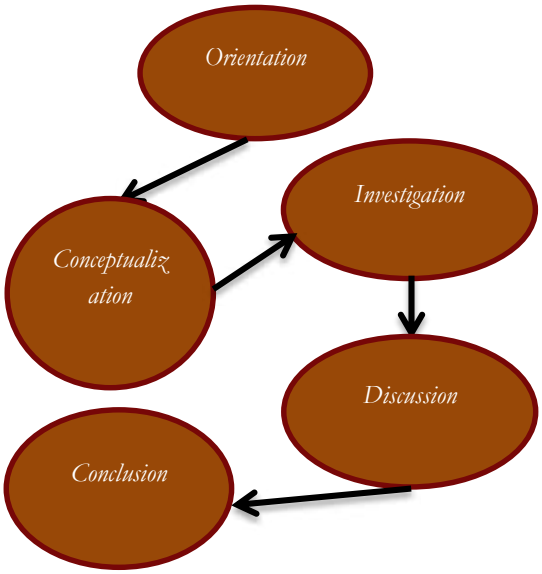

Figure 1. Data Analysis Techniques

Orientation, used to collect several articles from databases such as Scopus, Google Scholar, and ERIC (Education Resources Information Center), with the help of the POP (Publish or Perish) application related to a predetermined research topic, Conceptual-ization, useful for separating scientific articles that are relevant to the research theme, namely the Guided Inquiry model of scientific literacy, Investigation, useful for analyzing data that has been separated and used for data in completing discussions, Discussion, useful for techniques used in describing discussions supported by data that has been analyzed previously, and Conclusion, this stage is used in making conclusions according to the data that has been analyzed and studied previously. Then the basic foundation of meta-analysis is Effect Size, so to answer the research problem formulation it is necessary to use meta-analysis techniques on the magnitude of the influence of Effect Size. The following is the category of Effect Size values according to *Cohen's d*:(Cohen et al., n.d.)

Table 3. Category Effect Size Value

Value	Category
$0{,}2 \leq d < 0.5$	Low
$0{,}5 \leq d \leq 0.8$	Medium
d>0.8	High

RESULTS AND DISCUSSION

Results

1. Effect Size Result Data Based on Category

Data on the effect size of the Guided Inquiry learning model, Discovery Learning model, and Problem-Based Learning model on scientific literacy can be seen in table 4 as:

Tabel 4. Effect Size Based on Category

Model	Article Code	*Effect Size*	Mean *Effect Size*	Category
GI	1A	1,51	2,65	High
	6A	0,91		
	21A	1,45		
	26A	2,29		
	30A	3,70		
	33A	2,4		
	44A	6,29		
DL	47B	0,40	2,10	High
	53B	0,50		
	54B	1,00		
	56B	6,52		
	91C	3,65		
	96C	4,15		
PBL	98C	1,92	2,18	High
	105C	0,69		
	106C	1,04		
	107C	2,93		
	108C	2,39		
	109C	0,72		
	111C	2,19		

The results of the analysis in Table 4 above show that the Effect Size of the Guided Inquiry model has a high category with several scientific publication articles as many as seven articles and the average Effect Size is 2.66. The Discovery Learning model has a high category with four scientific publications and an average effect size of 2.11. The Problem-Based Learning model has a high category with nine scientific publications and an average effect size of 2.19.

2. Effect Size Results Based on Education Level

Educational level is one of the points that can be analyzed, which consists of the most basic education levels, namely Elementary School (SD), Junior High School (SMP), Senior High School (SMA), and University. The results of the Guided Inquiry Model Effect Size data on scientific literacy based on educational level can be seen in Table 5 below:

Table 5. *Effect Size* Based on Education Level

Model	Education Level	Number of Articles	Mean *Effect Size*
GI	SD	1	2,29
	SMP	1	2,44
	SMA	4	3,13
	PT	1	1,45
DL	SD	-	-
	SMP	2	3,46
	SMA	2	0,75
	PT	-	-
PBL	SD	1	0,69
	SMP	3	2,20
	SMA	5	2,47
	PT	-	

In table 5, the Guided Inquiry model for elementary, middle, high school, and University levels has an average effect size that is categorized as high. The Discovery Learning and Problem-Based Learning models at the SMA and SD levels are still in the moderate category.

3. Result of Effect Size Based on Time Zone in Indonesia

The results of the Guided Inquiry model's effect size data on scientific literacy based on time zones in Indonesia can be seen in table 6 below:

Tabel 6. *Effect Size* Based on Time Zone in Indonesia

Time Zone Indonesia	Article Code	*Effect Size*	Mean *Effect Size*
WIB	21A	1,45	3,40
	33A	2,44	
	44A	6,29	
WITA	1A	1,51	2,10
	6A	0,91	
	26A	2,29	
	30A	3,702	
WIT	-	-	-

In table 6, in the time zone in western Indonesia, there are three scientific articles with an average of 3.40. In the Central Indonesian Time Zone, there are four scientific articles with an average of 2.10. In the Eastern Indonesian Time Zone, not a single scientific article was found with an average Effect Size of 0.

Discussion

1. The Effect of Guided Inquiry, Discovery Learning, and Problem-Based Learning Models on Scientific Literacy Based on Overall Categories

From the data that has been obtained, it is found that the effect of the Guided Inquiry, Discovery Learning, and Problem-Based Learning models on scientific literacy is based on categories. Where the Guided Inquiry model has an average Effect Size of 2.656 in the high category, the Discovery Learning model gets an

average Effect Size of 2.109 in the high category, and the Problem-Based Learning model gets an average Effect Size of 2.186 in the high category. With the results of these categories, the three models have a high influence on improving students' scientific literacy skills.

After doing a comparison between the Guided Inquiry, Discovery Learning, and Problem-Based Learning models on scientific literacy by category. It can be seen that the Guided Inquiry model has the highest average Effect Size on scientific literacy skills. In other words, the experimental group that uses the Guided Inquiry model on scientific literacy has a more effective influence than the control group. Therefore the Guided Inquiry model can be an alternative model that can be used in the learning process to improve students' scientific literacy abilities.

The Guided Inquiry model is very effectively used to improve students' scientific literacy skills. The research that was conducted by Yuni Erdani, et al stated that the Guided Inquiry learning model affected improving students' Science literacy skills with an average post-test result of the experimental class of 83 and the post-test of the control class 72.20.(Erdani et al., 2020) Where the Guided Inquiry model has the main goal of developing the attitudes and skills of students to solve problems independently with the guidance of educators. Solving problems through an inquiry process is one of the elements of contextual learning activities. Contextual learning with problem-solving is an aspect of scientific literacy. Not only that, one of the factors for students' low scientific literacy is the lack of initial understanding when learning activities take place. This initial understanding can be obtained with the help of a stimulus from the educator. Whereas the Guided Inquiry model includes a learning model that provides an initial understanding stimulus carried out by educators. In other words, the Guided Inquiry model is effectively used to improve students' scientific literacy skills in the learning process.

2. The Effect of the Guided Inquiry Model on Scientific Literacy Based on Education Level

Based on the results of the Effect Size data, the effect of the Guided Inquiry model on scientific literacy based on educational level can be seen in Table 5. The data shows that the Guided Inquiry model at the elementary, middle, high school, and tertiary educational levels has an average effect size that is categorized as high. The Discovery Learning and Problem-Based Learning models at the SMA and SD levels are still in the moderate category.

After obtaining the Effect Size data on the effect of the Guided Inquiry model on scientific literacy based on educational level, it can be seen that each level of education has high results. So that the Guided Inquiry model is very effectively used in the process of teaching and learning activities to improve students' scientific literacy skills at any level of education. Other models such as Discovery Learning and PBL are also effective for increasing scientific literacy skills, even though at the high school and elementary education levels the two models are still in the low category. Previous research at the junior high school (SMP) level conducted by Yuni Erdani stated that learning using the Guided Inquiry model could increase students' scientific literacy at the junior high school level.(Erdani et al., 2020) In fact, in another study conducted by Umm Aiman et al at the elementary school level, it was stated that there was an increase in the mastery of scientific literacy skills in students after being taught using the Guided Inquiry model. (Ummu Aiman, Dian Meilani, 2021) Other previous research on the Discovery Learning model conducted by Rahmi Laila stated that the Discovery Learning model is in the middle category in terms of increasing students' scientific literacy skills.(Laila & Firaina, 2020) According to Lenty Supriwardi, in research on the effect of the PBL model on scientific literacy, it was stated that the PBL model was effectively used in learning from elementary school to high school, even though at the junior high school level scientific literacy skills were in a low category.(Lenty Supriwardi, Zulyusri, 2021) Several factors cause differences in grades at the level of elementary school to tertiary education, namely 1) Lack of learning activities after the course, 2) Differences in learning methods used by educators at each level of education, and 3) Lack of student motivation to improve scientific literacy skills. Even so, the Effect Size score at the tertiary level is still in the high category.

3. The Effect of the Guided Inquiry Model on Scientific Literacy Based on Time Zone in Indonesia

This study found that the effect of the Guided Inquiry model on scientific literacy based on the Indonesian time zone has an Effect Size value of 3.40 with three scientific articles in the western part of Indonesia, while in the Central Indonesian time zone, it has an Effect Size value of 2.103 with four scientific articles, for In the eastern Indonesian time zone, the authors did not find scientific articles discussing this model, so the Effect Size value is 0.

The researcher chose the time zone as a regional classification in Indonesia to facilitate data collection on the scientific articles that were collected, because the number of articles obtained was relatively small. Then for the western Indonesian time zone it consists of three scientific articles where one scientific article comes from the island of Sumatra and two other scientific articles come from the island of Java. For the central part of Indonesia's time zone, it consists of four scientific articles originating from four different islands, namely Bali, Sulawesi, NTT and NTB.

From the results of the Effect Size data in Table 6, there is a difference between the Western Indonesian time zone and the Central Indonesian time zone. Where the difference in the Effect Size value reaches 1.3 between these time zones. In terms of the number of articles, the central part of Indonesia's time zone is more than the western part of Indonesia's time zone. But the western part of Indonesia's time zone has a higher Effect Size value. Many factors cause this difference besides the high Effect Size value, namely, educational facilities in the western Indonesian time zone are superior to other Indonesian time zones, then the better quality of educators also influences students to improve their scientific and technological literacy skills. A good one can make it easier for students to add information and facilitate student learning activities. Although there are differences in the effect of the Guided Inquiry model on scientific literacy between the Western Indonesian time zone and the Central Indonesian time zone, the Effect Size values of the two time zones are already relatively high and prove that in some areas of Indonesia, the Guided Inquiry model is effectively used to improve students' Science literacy skills.

CONCLUSION

Based on the analysis of the research findings that have been carried out, it can be concluded that the influence of the Guided Inquiry model based on category has the highest average compared to the Discovery Learning and Problem-Based Learning models. Where the average Guided Inquiry Effect Size is 2.656 in the high category, the Discovery Learning model has an Effect Size of 2.109 in the high category, and Problem-Based Learning has an Effect Size of 2.186 in the high category. This shows that the Guided Inquiry model has a positive and effective impact to be used in the process of learning activities to improve students' scientific literacy skills.

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